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EXPERIENCE IN THE USE OF SEISMOGRAPHIC PROSPECTING UNDER WINTER CONDITIONS IN THE KUYBYSHEV REGION ALONG THE VOLGA

Razvedka i Okhrana Nedr [Prospecting and Conservation of Natural Resources], No 2, February 1956, Moscow, Pages 36-42

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In 1952 the "Kuybyshevneftegeofizika" [Kuybyshev Petroleum Geophysics] Trust began to carry out systematic winter seismic operations by the method of reflected waves. The 3 years of experience that the trust has gained in organization and performance of winter operations merit wide elucidation for the purpose of transmitting it to other geophysical organizations.

Winter seismic operations should occupy a definite specific weight in the general volume of geophysical investigations, mainly in the districts of the eastern outskirts of the Russian plain, in Siberia, and in the Far East.

The industrial expediency of conducting winter seismic operations in the Kuybyshev regions of the Volga River can be explained by the need for a sharp rise in the effectiveness of the seismic method of prospecting in general. One of the basic questions relating to successful solution of this problem is the securing of continuity in operating process, i.e., the shift of seismographic prospecting to round-the-year operation.

Thus, the following positive moments are being achieved in practice:

(1) qualified cadres of the summer-season seismic parties, not engaged in office work in the winter are retained and utilised more rationally; the technician-operators, the technician-blasters,

the technicians in drilling, the administrative workers, the bookkeepers and skilled workers (blasters, drillers, chauffeurs);

(2) more complete use is made of the prospecting apparatus and equipment which, after the end of the summer field work, is usually put in storage for a long time (more than 4 months) until the beginning of a new field season.

It is also necessary to consider that in a number of districts promotion of winter seismic operations is also dictated by specific conditions of locality. There are marshy flood plain sections with substantial number of water obstacles present (lakes, rivers, old river beds, et al.), where it is in general impossible to carry out seismic operations in summertime.

The first winter seismic operations were conducted by the "Kuybyshevneftgeofizika" Trust in the winter of 1952-53 by one party in the southeastern part of Samarskaya Luka near the city of Kuybyshev. In the main the work had an experimental character and was conducted with the object of determining the possibility of carrying out winter seismic operations in the Kuybyshev region along the Volga River.

The main equipment of the party had not been fully adapted to winter conditions and was employed in the operation in the following form. The body of the seismographic station was completely removed (together with the apparatus) from the chassis of the motor truck and set up on a sled in a specially heated booth which was warmed by an iron stove. In regard to the remaining equipment employed in the operation, heating was provided by one auto-tank and one auto-blasting-station.

For warming the drilling-brigade workers, special wooden booths were built. These were mounted on sleds and also equipped with iron stoves.

The travel of the special motor truck in the field was done along roads specially cleared by means of an angle scraper. With the snow cover well cleared off, the motor truck travelled mainly on its own power.

Due to the lack of special devices for warming the drilling machines, drilling was practically stopped when the temperature was -15°C, owing to frozen water in the circulation system. For the reason indicated, the productivity of drilling was extremely low, and during the 3 months of the party's operation 30 blast holes in all with a total length of 850 m were drilled.

To sum up, the main results of this first stage of winter seismic operations amounted to the solution of a number of methodological and organizational problems on the employment of seismographic prospecting underwinter conditions.

As a result of the operation, it was established that for the successful completion of winter seismic operations the following are of exceptionally great importance: the choice of the plot for drilling blast holes, the conditions of getting reflections from relatively shallow depths, and the organization of drilling work and heating arrangements.

In the winter of 1953-54 the "Kuybyshevneftegeofizika" Trust conducted seismic operations with the manpower of 2 single-detachment parties in the Kinel'-Cherkasskiy oil-bearing district of Kuybyshev Oblast on sections affording comparatively easy conditions for drilling blast holes and getting reflections.

The object assignment of the work of the parties was the further elaboration of the methods and technology of field operations under winter conditions and the prospecting of the buried structures for reflecting levels in the Carbonic and Devonian formations.

The operations were carried out by seismic stations of the SS-24-48 type, the equipment of which was mounted in special heated booths on wooden sleds, moved across profiles by S-80 tractors.

The drilling of blast holes was done by drilling machines of the AVB-T and the AVB-3-100 types. At temperatures to -15° or -18°C the drilling was done by the water-washing method; at lower temperatures the holes were drilled dry with drill spoons. This method did not justify itself because of the extremely low productivity.

For warming the drill brigades and blaster brigades in the parties, special booths were provided which were mounted on wooden sleds and moved across the sections by tractors. The haulage of technical water for drilling and to the blast holes was done by auto-tanks and auto-blasting stations, which were towed by tractors due to the lack of roads. Roads across the profiles were usually cleared by scraper and bulldozer.

However, the equipment that was used in the winter season 1953-54 did not prove sufficient for the normal course of operation. As before, the tight spot remained the drilling of blast holes.

Owing to the lagging of drilling, the winter parties did not fulfill the physical volume of work set by the project. The area explored by both parties amounted to 105 km^2.

In the main the quality of the seismic material gained was good.

It secured continuous tracing of thrust-reflecting levels in the Carbonic and Devonian formations.

The main results of the winter seismic operations of the second stage thus not only brought about the solution of the methodologic and organizational problems, but also advanced to a certain extent solution of the geological assignment.

The most successful winter seismic operations were carried out in the period 1954-55. To heighten the effectiveness of winter operations in 1954-55, one 2-detachment party was organized which carried out the investigations, instead of the single-detachment seismic parties.

The work assignment of the winter seismic party of 1954-55 was the contour mapping of the eastern periclinals of structures which had been partially prospected along deep levels of the Carbonic and Devonian formations by the seismic operations of the summer period of 1954, and also the further perfection of the methods of winter seismic operations in the Kuybyshev region along the Volga.

For more successful promotion of the winter seismic operations than had been attained in previous years, the party which operated in 1954-55 was outfitted substantially with specially-prepared equipment and gear; also utilized in part was the equipment of the seismic party that had worked in the summer period. In consequence the complete set of equipment of the 2-detachment seismic party consisted of the following units:

(1) Seismographic station of the SS-51-D-F type with speed filters from a set of SP-16 type seismographs;

(2) Drilling machines of A B-T type (on tractors) (5 items);

(3) Drilling machine of the BS-3A type (screw conveyor, one set);

(4) Auto-tanks on motor cars (2 items);

(5) Auto-blasting stations on motor cars (3 items);

(6) Sleds with booths and 2 heated tanks (2 sets);

(7) Bulldozer (1 item);

(8) S-80 transport tractors (2 items);

(9) Oil and water heaters (2 items).

A brief description is given hereunder of the arrangement and assignment of the main units specially made or adapted for the winter seismic operations.

(1) Metal sleds (see Figure) which were employed in the 1954-55 operations showed comparatively high operating qualities. Notable were their adequate capacity, great durability, and relatively small weight (1.3 t).

(2) All equipment of both seismographic stations was mounted in one specially heated booth, fastened in appropriate manner to a metal sled (see Figure). The booth has 2 sections: the first (rear) is for warming the workers' brigade and the second (front) is for accommodating the equipment. Admittance to the equipment is through the first section. For protection of the equipment from shock during travel of the sled across rough roads, special shock-absorbing devices were applied. Each set of equipment, together with a frame, was set up on a rubber pad (auto tire), and the top of the frame was fixed to special springs.

Heating of the equipment and the station . it as a whole was

done with an iron stove placed in the first section; temperature was maintained as normal as possible over the whole 24-hour period.

The seismic station unit equipped in such form was moved across profiles by an S-80 tractor.

(3) For haulage of technical water to the drilling machines and the blasting brigades, specially prepared units were employed. These were mounted on metal sleds and consisted of 2 tanks of 2.5 m^3 each and one heated booth designed for warming the workers of the drilling or blasting brigades. With the object of protecting the water from freezing, the tanks were sheathed with boards. The space between the tanks and the sheathing was filled with wood sawdust.

(4) The pumping unit on a metal sled was designed as a mechanized means of pouring technical water from the reservoir into the tanks. The unit consists of a wooden heated booth and the pumping installation proper. The centrifugal pump of a capacity of 300-500 l/min was driven by an L-6/2 engine. Such an installation permits filling a volume of 2.5 m^3 in 10 to 15 minutes.

In field conditions the installation is placed directly near the reservoir which is situated close to the working place.

(5) The drilling of blast holes was done by AVB-T machines (on S-80 tractors) with water washing of the shaft, by a screw-conveyor machine of PS-3A type, and AVB-T machines reconstructed as screw-conveyor models (for drilling dry).

Operating practice showed that drilling with screws (dry) in winter conditions has a number of substantial advantages as compared to drilling holes with water.

The effectiveness of drilling with screws is particularly

evident in the case of AVB-T machines, because the motor of this unit has substantially greater power than that in the BS-3A screw device. Consequently, the required depths of holes (20 to 30m) [illegible] comparatively easily, and travel across the profile is assured by the tractor of the drilling machine itself, even when properly-cleared roads are lacking.

On some days the productivity of the AVB-T drilling machine with screws reached as much as 2 holes, 25 m in depth, per shift.

To speed up the drilling with screws, a small amount of oil is added in the hole. This reduces the friction of the screws on rock, facilitates a better removal of drilled rock, and prevents breakdowns connected with wedging and seizing of the screws. A machine of new design USHB-1 type also showed good results in drilling holes dry.

It is necessary to note that drilling with screw-conveyor machines is applied with success in running sands, strongly aquiferous levels, and when hard rocks are absent in the hole.

(6) With the object of creating the necessary conditions for the normal work of the drilling brigades at the profile during low temperatures and strong winds, protective accomodations consisting of canvas screens 3 x 4 m in size, comparatively easy to develop and convenient to use, were proposed by the "Kuybyshevneftegeofizika" Trust.

At every drilling machine 2 or 3 such screens are required; one end of the screen being fixed to the ground with iron pickets, and the other to the derrick of the machine by means of special guys. The screens are fastened (set up) from the lee side and at a definite angle to the derrick so that the drilling brigade may --

without hindrance and with observance of safety rules -- carry out all operations in servicing the drilling unit.

During the field season the party drilled 170 holes with a total footage of 4,480 m and processed 65 km of profile in an area of 150 km^2.

In a methodologic aspect, the operations in the profiles were done by paired stations with the method of continuous contour mapping from 3 points of blasting.

The distance between the blast holes was set at 500 m, and the distance between seismograph receivers at 20 m. For connecting the seismograph receivers there were 2 switches, each 500 m long.

The adopted method of operating from 3 blast points provided for continuous correlation of reflections in a period of 0.4 seconds and heightened the accuracy of the correlations of the reflections from the main levels of the section on account of one-and-a-half overlapping. This afforded the possibility of elucidating the structure of the upper part of the section without additional work by the method of refracted waves.

In a volume of up to 10% the party carried out operations with the use of speed filters. The application of the filters showed their effectiveness for choking surface waves with a spread velocity of 350-450 m/sec, which arise during blasts in shallow holes (near the foot of ZMS). In winter operations, when the drilling of blast holes is an extremely labor-consuming process, the obtaining of reflections with blasts in shallow holes (10 to 15 -) has an importance in principle.

The factual material obtained by the party is characterized

by good quality in general, providing a continuous tracing of reflections from levels in the Carboniferous and Devonian formations.

The structural maps plotted on various levels of Paleozoic deposits elucidated the structure of the district from the lower Permian to the Devonian formations and were in complete accord with the results of the work of the party that had conducted operations in an adjacent district in the summer period.

Conclusions

Proceeding from the available experience of conducting winter seismic operations in the system of the "Kuybyshevneftegeofizika" Trust, it is necessary to draw the following main conclusions and to make proposals for their further development and improvement.

Selection of the Section for Prospecting and Organization of Work

In the planning for seismic operations in the winter season it is necessary to have in mind sections that meet the following main conditions:

(1) close proximity to the railway and to large technical enterprises (machine-tractor station, state farm, et al), to provide for operative contact with the trust and organizations, and also for timely repair of apparatus and equipment;

(2) presence of relatively even relief of the terrain, which will secure the rectilinearity of the seismographic contour, and also the unobstructed and safe travel of all kinds of transport;

(3) conditions of drilling must be comparatively light (desirably sandy-clayey deposits); besides, the maximal depth of the holes must not exceed 30 to 50 m.

In solving the organizational problems, it is most expedient

to combine the liquidation period of one of the summer parties with the organisational period of the winter party. In this case auxiliary premises, part of the equipment, and even manpower of the summer season party can be utilized to a considerable extent. Moreover, in the summer period appropriate reconnaissance of the area of winter operations can be carried out and data obtained on the conditions for executing prospecting operations in the given relief, section, etc.

The one-detachment winter seismic party is, owing to the short term of the field season (2 to 3 months) and the specific conditions of winter work, able to complete an extremely limited volume of investigations. Therefore, considering a number of economic and other factors, it is necessary to concentrate the winter operations, organizing 2-detachment or perhaps 3- and 4-detachment parties in one area. Besides, the section of operations in the winter period must be located in territory directly adjacent to the areas of the prospecting of the summer seismic parties, and must be able to form with them a unified whole for consequent solution of geological tasks.

The Method and Technology of Winter Operations

Depending on the concrete conditions of the section being surveyed (depth of holes, lithological composition of the rocks, et al.), the drilling of blast holes during winter operations must be done dry (with screw conveyors) and with water washing. For dry drilling it is rational to use UShB-1 screw-conveyor machines and AVB-T tractor machines, reequipped as screw-conveyor machines. For drilling with washing, the usual AVB-T tractor machines are recommended. For warming the drilling brigades at the profile, the employment of heated booths and canvas screens is recommended.

For delivery of technical water to the blast holes, it is rational to employ tanks mounted together with booths on metal sleds.

The filling of tanks with water can be successfully done by means of a special pumping installation that is in a heated booth.

During drilling operations the sleds with the tanks can be moved across the profiles unobstructedly by the tractor machines, and during blasting operations by the S-80 transport tractors.

In the conditions of the Kuybyshev district along the Volga the following method fully justified itself: continuous contour mapping by paired stations from 3 points of blasting with distances of 500 m between holes and 10 to 20 m between seismograph receivers. Application of the method indicated (one-and-a-half contour mapping) provides for securing short (1000 m) and long (2000 m) hodographs of the reflected waves. Besides, reliability of the correlations is heightened and the possibility attained of more complete utilisation of the entire factual material on account of the additional construction of the reflecting areas by the method of cross bearings on elongated hodographs. At the same time the use of the given method permits curtailing considerably the volume of additional operations by the method of refracted waves.

The employment in the operation of paired seismographic stations mounted in one booth on a sled has a great economical effect; drilling footage increases on account of the diminished number of blasts, the reduction in volume on redrilling and expenditure of special materials, reduction of transport means etc. Simultaneously with this, better organisation of labor in profile is secured.

Employment of seismic stations with speed filters also has

positive importance during winter operations, since in this case certain reflections can be attained with the use of shallow holes.

Clearing Roads and Transporting Equipment

When the snow cover is greater than 0.5 m, the problem of clearing roads across the profiles for the travel of technical equipment acquires particular importance. This kind of work can be performed both by a bulldozer and by the S-80 tractor with a metal angle scraper.

Practically speaking, the use of the bulldozer, through which high productivity is secured in clearing ways and high quality work (width of road, sidings, turns, etc) is regarded as the most expedient. Use of a metal angle scraper is recommended for opening roads on tilled sections; in this case, by means of its weight, the scraper levels off very well the roughness of the ploughland.

Standard Equipment

The specific conditions of winter operations (lack of roads and low temperature) predetermine the special demands on the equipment used in the work. Proceeding from available experience, the following technical equipment of 2-detachment seismographic parties is recommended:

(1) Set of equipment of 2 26-channel seismic stations with speed filters of the SS-52-D-- type; in paired work the equipment of the seismographic stations must be installed in one heated booth; the equipment of one 60-channel seismographic station can also be used with success.

(2) Drilling machines AVB-T (from 4 to 5 items).

(3) Units of screw-conveyor UBhB-1 drilling machines; the number is determined by the concrete conditions of drilling.

(4) Sleds with booths and tanks for brigades of blasters (according to the number of blasting points).

(5) Sleds with booths and tanks for the brigade of drillers (according to the number of tractor machines).

(6) Pumping installations (for filling the tanks with water) (1 unit).

(7) S-80 transport tractors (5 items).

(8) Bulldozer (1 item).

(9) Metal angle scraper (1 item).

(10) Auto-tanks and auto-blasting stations (2 each) for use in the spring and autumn periods.

(11) Oil and water heaters (2 items).

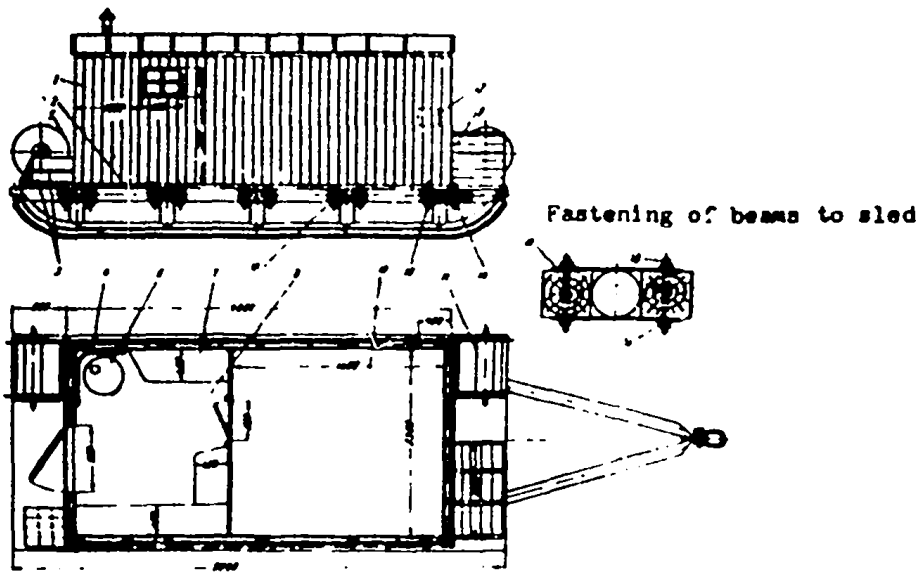
For warming the special units at the profile and heating the working premises, it is necessary that the party have fuel for the winter season in the amount of 150 m^3 of firewood and about 20 t of coal.

In conclusion it should be noted that the effectiveness of winter seismic operations can be heightened to a considerable extent both in an economic sense and from the viewpoint of solving geological tasks, if the basic units for these operations were to be produced serially at appropriate plants.

There are grounds for thinking that in the future the experience gained in the use of seismographic prospecting under winter conditions

in the Kuybyshev region along the Volga River will be used with success in the organization of year-round seismographic parties in enterprises of Glavneftegeofizika and in the system of the Ministry of Geology and the Conservation of Natural Resources.

FIGURE



Figure, page 38 [of original]. Booth for seismographic station on sled. 1. booth; 2. sled; 3. boxes for seismographs; 4. screen; 5. rear coil; 6. stove; 7. benches; 8. place for workers; 9. box for firewood; 10. place for equipment; 11. front coil; 12. window for panel with small door; 13. fastening bolts; 14. nuts; 15. fastening straps